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FRAUNHOFER INSTITUTE FOR MACHINE TOOLS AND FORMING TECHNOLOGY IWU

SPIN EXTRUSION

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Process description

Spin extrusion is an incremental, rotational compressive forming process to produce hollow parts out of solid cylinders which has been devoloped at the Fraunhofer IWU and the Chemnitz University of Technology. The process combines the principles of backwards cup extrusion and flow forming; it is a bulk metal forming process. Depending on the production task and the material, forming can be cold, warm or hot.

The workpiece is clamped to the spindle and rotates around its axis. The mandrel is turning synchronously to the spindle. The spinning rollers and the mandrel are at a defined distance to one another and perform a synchronous, axial movement. The material displaced by the spinning rolls and by the simultaneously, axially acting mandrel flows off axially in the opposite direction of the feed, thus forming a cup wall. The formation of the outer contour by the spinning rolls also enables hollow parts that are stepped. The inner contour can be generated into different cross sections according to the mandrel geometry, such as circular profile, polygon or internal spline profile. The locally acting spinning rolls do not plastify the material in the total forming volume. The deformation is realized in increments, locally and temporally limited, which reduces the forming forces and the required drive powers.

Process advantages

Compared to deep hole drilling, a significant advantage is the much higher material exploitation (approx. 90 percent) combined with considerably reduced material input. This makes this process especially attractive for processing expensive materials. Compared to impact extrusion, spin extrusion is advantageous, especially when generating thick-walled hollow parts or parts with steps. Generally, this is valid for diameter-wall thickness ratios of D:s < 5. Furthermore, spin extrusion does not require chemical pre-treatment of the surface. Due to kinematic shaping this process is highly flexible, making elaborate dies unnecessary. Its economical feasibility thus extends as well to small batch manufacturing.

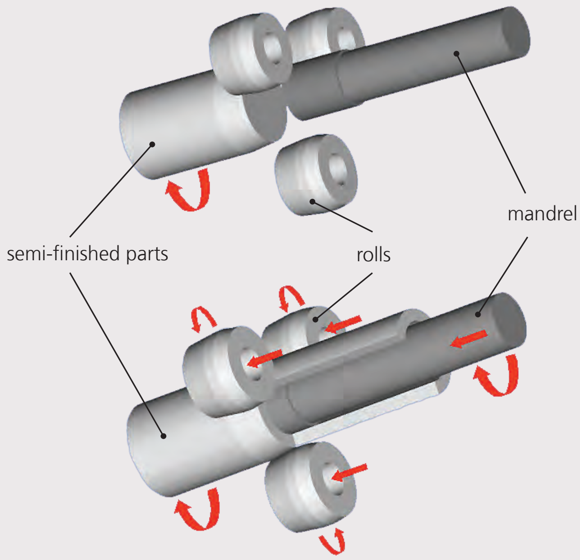
1 Spin extrusion machine

2 Spin extrusion, starting with a forging part

3 Selection of inside profiles made by spin extrusion

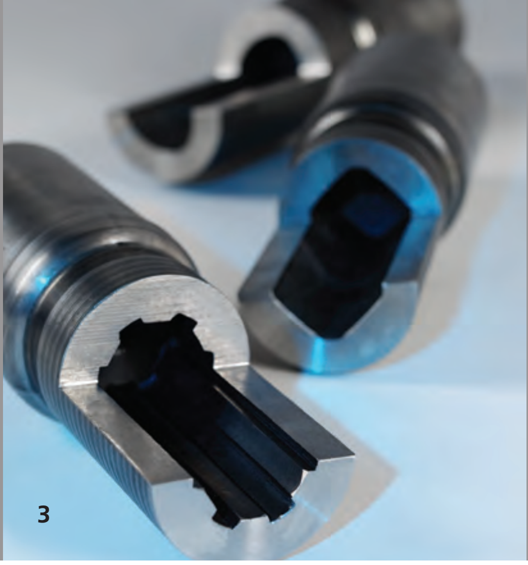
4 Producible wall thicknesses

Basic principle of spin extrusion



Potential for lightweight construction

The integration of hollow shapes into the powertrain of road vehicles represents a considerable potential for innovation. Especially high demands are made on these parts in terms of strength, at the same time reduction of the part weight and the cost per piece. This can only be achieved if the development of modern production technologies is combined with the principles of lightweight construction and the application of high-strength materials.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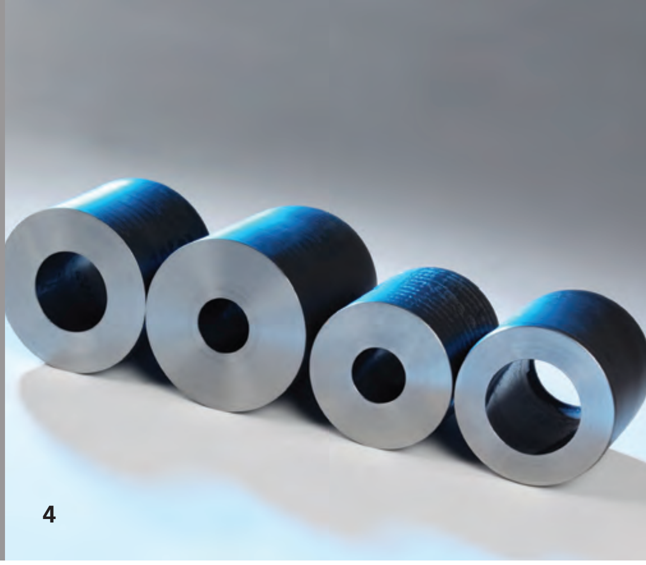
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The transmission of torques is the primary function of drive- and gear shafts. The torsional load on these components leads to shear stress in the cross section, with a maximum in the component cross section near the surface. The shear stress is insignificantly low in the core area.

If a solid shaft of an existing product is replaced by a hollow shaft of the same diameter with a mass reduction of 30 percent, the torsional rigidity is reduced only by approx.10 percent. This nonlinear relation can be made use of. It provides a significant constructive potential of substituting solid components by hollow components.

Range of services

Based on our experience, we offer integrated preliminary studies for solving your manufacturing tasks. The considerations include the product requirements as well as the commercial and technological production environment. We analyze the existing manufacturing organization and the initial situation of the production and derive the economically and technologically optimal production approach. The solutions comprise process design for either individual processes or entire process chains, including concepts for machines and tools. We conduct efficiency analyses and investigations of process interfaces. Extensive equipment for experimental feasibility studies is available at our testing facilities. We support you in the transition to serial production.

Prototype machine

The Fraunhofer IWU works with an experimental system that was developed at the Institute as a prototype for a spin extrusion machine. The machine features an extremely stiff machine frame, a machine tool spindle for large axial forces and high rotational speeds, and specific slides for additional functions. Refitting with additional units is basically possible, e.g. for an automated production process. The machine is equipped with seven NC axes.

Technical data of the BDM 2000

Mandrel force		2,200 kN
Roll force	axial	100 kN
	radial	300 kN
Spindle rpm		420 min^{-1}
Momentum at spindle		3,000 Nm
Main drive		125 kW

Processing range

Dimensions

– Blank diameter	up to 80 mm (bar steel)*
– Final outer diameter	20 ≤ Da ≤ 70*
– Final inner diameter	16 ≤ di ≤ 50*
– Maximum final length	li ≤ 550*
– Length-diameter-ratio	li : di ≤ 15
– Wall thicknesses	2 ≤ s ≤ 23
– Diameter-wall thickness ratio	3 ≤ Da:s ≤ 20*

* = depending on the forming machine, material to be formed and forming temperature

Geometry

– Gear hubs similar to DIN 5480
  m ≤ 1.5; 12 ≤ z ≤ 25; a = (30°), 37.5°, 45°
– Serrated hubs similar to DIN 5481
– Splined hub profiles similar to DIN 5471, DIN 5472
– Polygons P3G DIN 32711, P4C DIN 32712 and the like

Materials

– Mild steels and case hardening steels, carbon steels
– Nonferrous metals and their alloys
– High-strength, hard to form materials

The materials should have an elongation at fracture of more then 10 percent.

Publishing Notes
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